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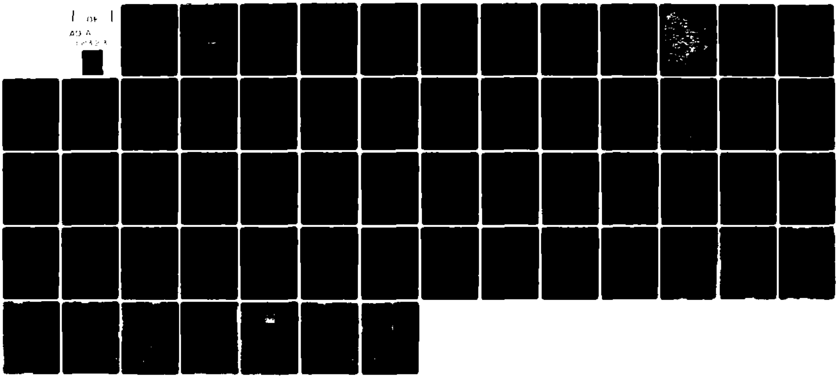

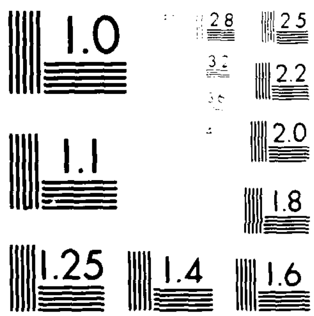

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GRAVITY SURVEY - CAVE VALLEY

NEVADA

Prepared for:

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Ballistic Missile Office (BMO)
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14 September 1981

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Gravity measurements were made in Cave Valley for the purpose of estimating the overall shape of the structural basin, the thickness of alluvial fill, and the location of concealed faults. The estimates will be useful in modeling the dynamic response of ground motion in the basin and in evaluating groundwater resources.

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FOREWORD

Methodology and Characterization studies during Fiscal Years 1977 and 1978 (FY 77 and 78) included gravity surveys in 10 valleys, five in Arizona, two in Nevada, two in New Mexico, and one in California. The gravity data were obtained for the purpose of estimating the gross structure and shape of the basins and the thickness of the valley fill. There was also the possibility of detecting shallow rock in areas between boring locations. Generalized interpretations from these surveys were included in Ertec Western's (formerly Fugro National, Inc.) Characterization reports (FN-TR-26a through e).

During the FY 77 surveys, measurements were made to form an approximate 1-mile grid over the study areas, and contour maps showing interpreted depth to bedrock were made. In FY 79, the decision was made to concentrate on verifying and refining suitable area boundaries. This decision resulted in a reduction in the gravity program. Instead of obtaining gravity data on a grid, the reduced program consisted of obtaining gravity measurements along profiles across the valleys where Verification studies were also performed.

The Defense Mapping Agency (DMA), St. Louis, was requested to provide gravity data from their library to supplement the gravity profiles. For Big Smoky, Hot Creek, and Big Sand Springs valleys, a sufficient density of library data was available to permit construction of interpreted contour maps instead of just two-dimensional cross sections.

In late summer of FY 79, supplementary funds became available to begin data reduction. At that time, inner zone terrain corrections were begun on the library data and the profiles from Big Smoky Valley, Nevada, and Butler and La Posa valleys, Arizona. The profile data from Whirlwind, Hamlin, Snake East, White River, Garden, and Coal valleys, Nevada, became available from the field in early October 1979.

A continuation of gravity interpretations was incorporated into the FY 80 and 81 programs, and the results are being summarized in a series of valley reports. Reports covering Nevada-Utah gravity studies are being numbered "E-TR-33-" followed by the abbreviation for the subject valley. In addition, more detailed reports of the results of FY 77 surveys in Dry Lake and Ralston valleys, Nevada, were prepared. Verification studies were continued in FY 80, and gravity studies were included in the program. DMA continued to obtain the field measurements, and there was a return to the grid pattern. The interpretation of the grid data allows the production of contour maps which are valuable in the deep basin structural analysis needed for computer modeling in the water resources program. The gravity

interpretations will also be useful in Nuclear Hardness and Survivability (NH&S) evaluations.

The basic decisions governing the gravity program are made by BMO following consultation with TRW, Inc., Ertec Western, and the DMA. Conduct of the gravity studies is a joint effort between DMA and Ertec Western. The field work, including planning, logistics, surveying, and meter operation is done by the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC), headquartered in Cheyenne, Wyoming. DMAHTC reduces the data to Simple Bouguer anomaly (see Section A1.4, Appendix A1.0). The Defense Mapping Agency Aerospace Center (DMAAC), St. Louis, Missouri, calculates outer zone terrain corrections.

Ertec Western provides DMA with schedules showing the valleys with the highest priorities. Ertec Western also recommended locations for the profiles in the FY 79 studies with the provision that they should follow existing roads or trails. Any required inner zone terrain corrections are calculated by Ertec Western prior to making geologic interpretations.

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1.0 INTRODUCTION

1.1 OBJECTIVE

Gravity measurements were made in Cave Valley for the purpose of estimating the overall shape of the structural basin, the thickness of alluvial fill, and the location of concealed faults. The estimates will be useful in modeling the dynamic response of ground motion in the basin and in evaluating ground-water resources.

1.2 LOCATION

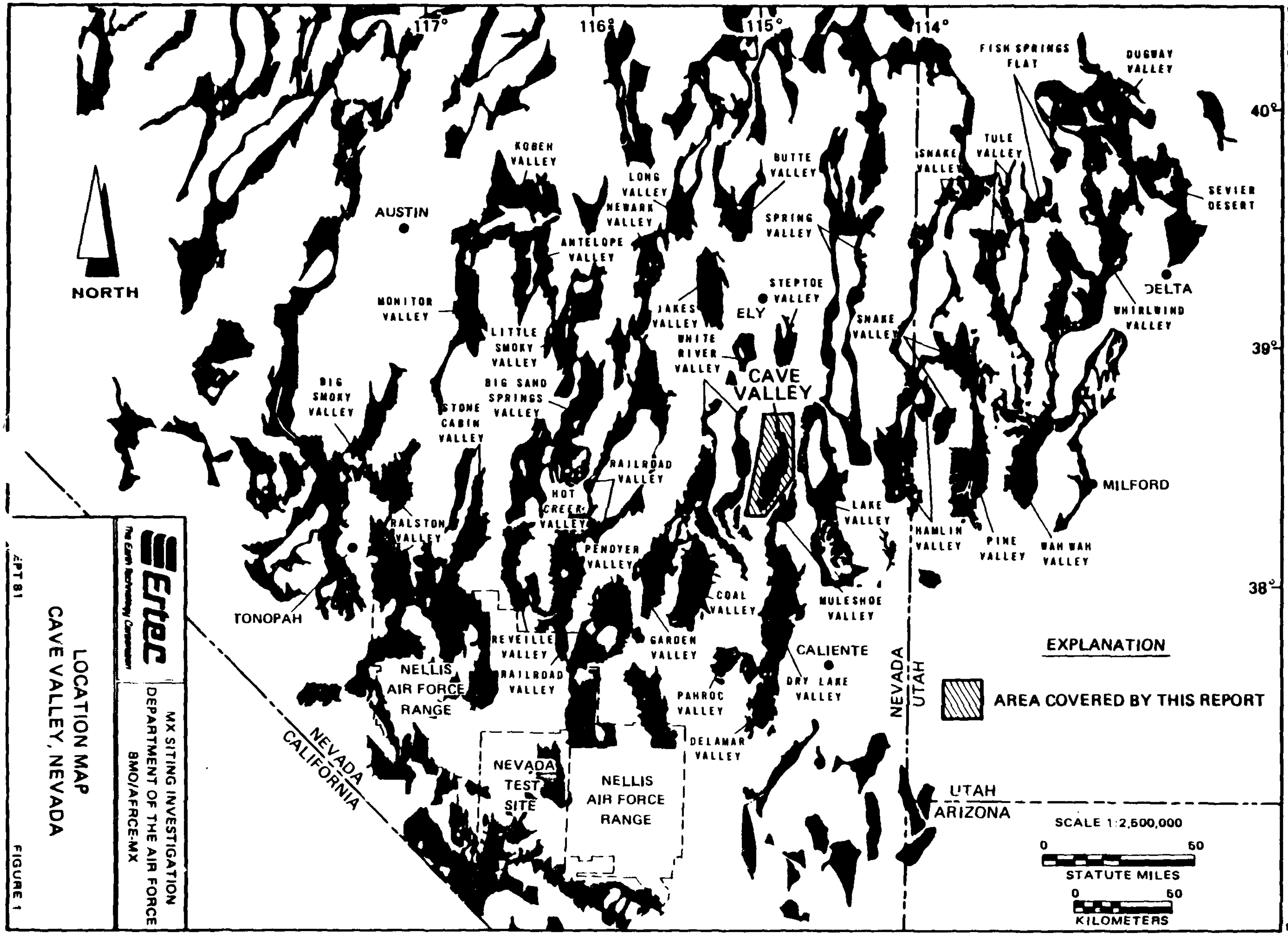
Cave Valley is located in east-central Nevada (Figure 1). It is approximately half way between Caliente and Ely, Ely being about 55 miles (88 km) north of Cave Valley. It is bounded on the east by the Schell Creek Range, on the west by the Egan Range, and opens to the south into White River Valley (Figure 2). Cave Valley is separated from Steptoe Valley to the north by convergence of the Egan and Schell Creek ranges.

The area covered by this report lies between 38°15' and 38°45' North latitudes and 114°40' and 115°00' West longitudes.

1.3 SCOPE OF WORK

Five primary work elements were completed during this study. They are:

1. Computation and merging of terrain corrections;
2. Synthesis of regional and valley-specific geologic data;
3. Evaluation of the regional field and residual separation;
4. Inverse modeling to estimate depth to bedrock; and
5. Interpretation of structural relationships.



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LOCATION MAP
CAVE VALLEY, NEVADA

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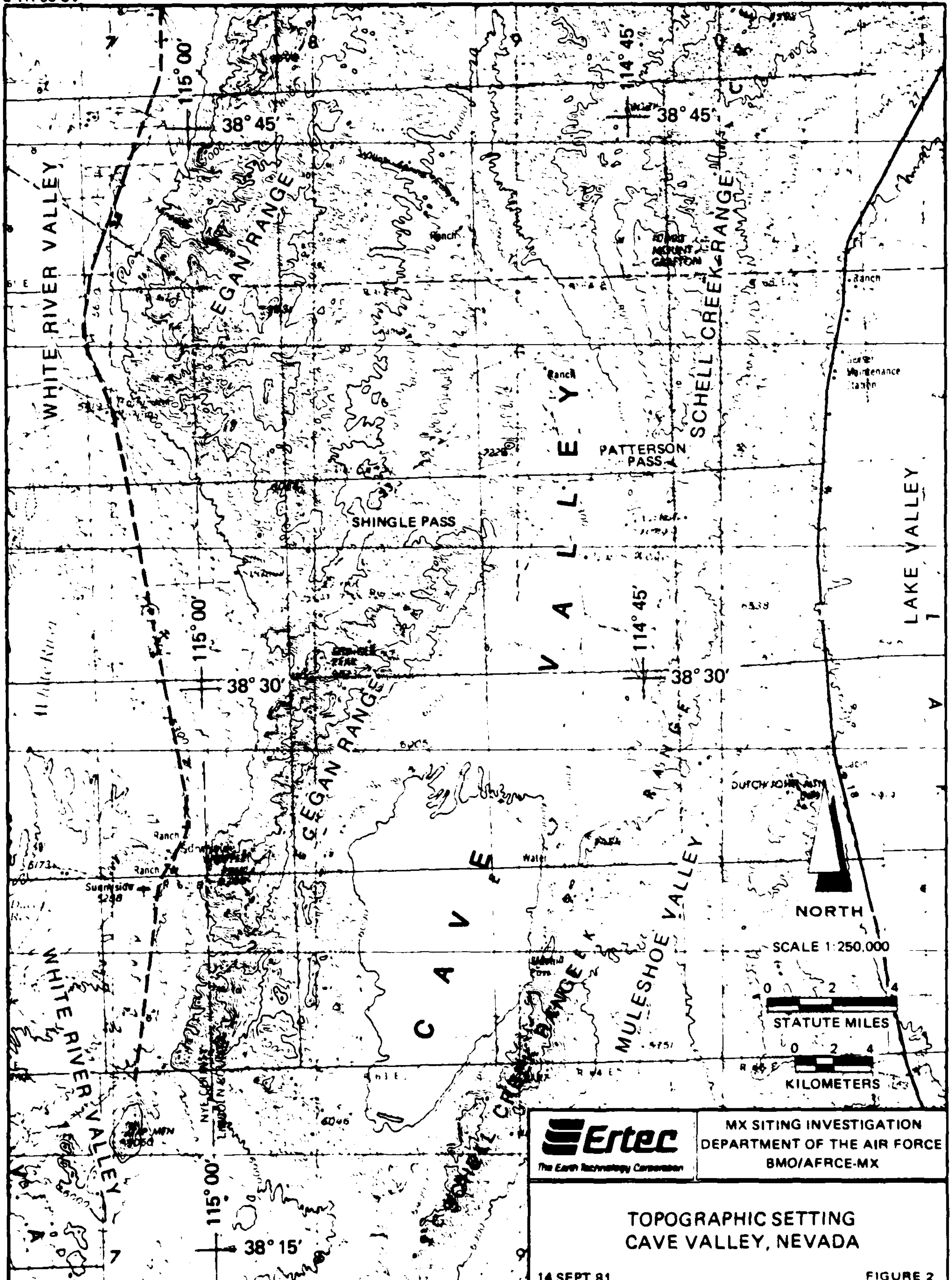
FIGURE 1



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TOPOGRAPHIC SETTING
CAVE VALLEY, NEVADA

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FIGURE 2

The gravitational field within Cave Valley was defined by measurements from 374 stations. The principle facts for these stations are listed in Appendix A2.0, and their distribution is shown in Drawing 1.0. The Defense Mapping Agency Aerospace Center (DMAAC) supplied 143 gravity stations from its library, and 231 new gravity measurements were made by the Defense Mapping Agency Hydrographic Topographic Center/Geodetic Survey Squadron (DMAHTC/GSS).

Cave Valley and Muleshoe Valley were studied together, with the results presented in separate reports. The rectangular region containing both valleys is the area between North latitudes 38°05' and 38°45' and West longitudes 114°35' and 115°00'. There are 522 gravity stations in the region. All were used to establish a common regional gravity trend for the two valleys.

Following residual separation, the geologic modeling of the two valleys was done independently.

2.0 GRAVITY DATA REDUCTION

DMAHTC/GSS obtained the basic observations for the new stations and reduced them to Simple Bouguer Anomalies (SBA) as described in Appendix A1.0. Up to three levels of terrain corrections were applied to the new stations to convert the SBA to the Complete Bouguer Anomaly (CBA). Only the first two levels of terrain corrections described below were applied to the library stations.

First, the DMAAC, St. Louis, Missouri, used its library of digitized terrain data and a computer program to calculate corrections out to 104 miles (167 km) from each station. When the program could not calculate the terrain effects near a station, Ertec Western used a ring template to estimate the effect of terrain within approximately 3000 feet (914 m) of the station. The third level of terrain corrections was applied to those stations where 10 feet (3 m) or more of relief was observed within 130 feet (40 m). In these cases, the elevation differences were measured in the field at a distance of 130 feet (40 m) along six directions from the stations. These data were used by Ertec Western to calculate the effect of the very near relief.

3.0 GEOLOGIC SUMMARY

Cave Valley is a north-northeasterly trending valley in the eastern portion of the Great Basin section of the Basin and Range physiographic province (Fenneman, 1931). It is bounded on the east by the Schell Creek Range and on the west by the Egan Range. On its southern boundary, Cave Valley is separated from White River Valley by rounded hills having low relief. On its northern boundary, it is separated from Steptoe Valley by a narrow gap between the Schell Creek and Egan ranges.

The Schell Creek Range is composed of faulted and deformed rocks which are uplifted relative to the surrounding area. In the southern part of the range surface exposures are Paleozoic in age. These rocks include as much as 15,000 feet (4572 m) of shale, sandstone, limestone, and dolomite that range in age from Upper Cambrian to Permian. Based on stratigraphic relationships in the northern part of the range, as much as 6000 feet (1829 m) of Lower Cambrian sediments and an unknown thickness of Precambrian sediments underlie the upper Paleozoic section. These older units are composed primarily of shale, sandstone, and quartzite. In the extreme southern part of the range, early Tertiary plutonic rocks have intruded the Paleozoic rocks.

In the central part of the Schell Creek Range, an unknown thickness of middle Tertiary volcanic rocks, andesite, and welded tuff covers most of the Paleozoic section except on the western flank of the range (Ekren and others, 1977; and Tschanz and

Pampeyan, 1970). Further north, the individual blocks making up the range have been uplifted to expose lower Cambrian rocks.

Like the Schell Creek Range, the Egan Range is composed of faulted and deformed blocks of rock. The surface rocks are generally Paleozoic carbonate, shale, and sandstone with the oldest rocks exposed anywhere in the range being upper Cambrian in age. There are about 26,000 feet (7925 m) of Paleozoic rock younger than lower Cambrian in the mountain range. About 80 percent of this is carbonate with the remaining being shale and sandstone (Kellogg, 1964). Volcanic rocks, mainly tuff, and sediments of middle Tertiary age cover the Paleozoic units in only a few areas (Kellogg, 1964).

The series of low hills that separate Cave Valley from White River Valley are composed largely of early to middle Tertiary volcanic rocks, but there are occasional outcrops of Paleozoic rock. Within Cave Valley itself, the surface is principally Quaternary age sediments although several blocks of Cambrian age rocks are exposed in the northern part of the valley. The sediments are principally nonindurated to partially indurated gravel, sand, silt, and conglomerate (Synder, 1964; and Mifflin and Wheat, 1979).

The present topographic relief of Cave Valley and the surrounding area is largely the result of late Cenozoic block faulting (Stewart, 1980). However, the effect of earlier tectonics, principally the Mesozoic overthrusting and early Cenozoic Laramide orogeny, is manifest in the absence of Mesozoic age

sediments and in the deformation of the Paleozoic and older sedimentary rocks.

4.0 INTERPRETATION

The basis of interpretation in this report is the Complete Bouguer Anomaly (CBA). Complete Bouguer anomaly contours and the gravity station locations are shown in Drawing 1.

The interpretation of irregularly spaced data is both difficult and inefficient. In order to simplify the interpretation, the CBA data were reduced to a set of values on the nodes of a regularly spaced grid. The value at each node was computed using a minimum curvature gridding program (Briggs, 1974; and Swain, 1976). Minimum curvature gridding is an iterative process, the purpose of which is to find the smoothest surface that fits the irregularly spaced data. This smooth surface is then used to interpolate between the existing data points. A 0.62-mile (1-km) grid spacing, which is slightly more dense than the average data spacing, was used throughout this analysis.

4.1 REGIONAL RESIDUAL SEPARATION

A fundamental difficulty in gravity interpretation is that the gravity expression of short wavelength, shallow, structural features of interest is overlapped and obscured by long wavelength features occurring at all depths. The purpose of a regional-residual separation is to remove the effect of the longer wavelength structures so that the features of interest may be correctly interpreted.

In order to estimate the form and magnitude of the long wavelength contribution (regional), the CBA was continued upward using a Fast Fourier Transform (FFT) and a frequency domain filter (Gunn, 1975). The data were continued upward to a height at which there could be seen no correlation between the upward continued CBA and the surface structure. This was at an altitude of 60,000 feet (18,288 m). The regional was then subtracted from the CBA and the resulting residual anomaly was further adjusted by a constant -8.0 mgal to make the zero residual contour approximately fit outcrops of Paleozoic carbonate rocks.

4.2 DENSITY SELECTION

The correct interpretation of the residual anomaly requires that one select density values that are truly representative of the subsurface rock. In this analysis, unfortunately, only very generalized density information was available. Three borings were drilled approximately 100 feet (30 m) into the alluvium of Muleshoe Valley during Verification studies (Ertec, 1981b). The average density measured at the bottom of these borings was slightly less than 2.0 g/cm^3. To account for compaction with depth (Woollard, 1962), a density of 2.3 g/cm^3 was assigned to the alluvium.

Basement rocks underlying the alluvium are assumed to be similar to rocks outcropping in the nearby mountains. These consist of Tertiary volcanic and plutonic rocks and Paleozoic carbonate and siliceous sedimentary rocks. Published values for the density

of the Paleozoic rocks typically range from 2.6 to 2.9 g/cm^3. Carbonate rocks in the Paleozoic section are the most dense with some in Nevada and Utah having values near 2.8 g/cm^3. The siliceous clastic sediments generally have densities in the range 2.6 to 2.7 g/cm^3. Densities representative of the Tertiary volcanic rocks range from 2.0 to 2.5 g/cm^3 for tuffaceous material, depending on the degree of welding, compaction, and alteration; 2.3 to 2.6 g/cm^3 for the andesite and rhyolite flows; and 2.6 to 2.7 g/cm^3 for the plutonic rocks.

4.3 MODELING AND SOURCES OF ERROR

Modeling was accomplished using three computer programs. Two of these programs compute the gravitational effect of two- and three-dimensional bodies (Talwani and others, 1959; and Plouff, 1975). The third program calculates an inverse three-dimensional solution (Cordell, 1970). The two forward modeling programs were used to augment the inverse modeling program because the inverse program is capable of handling only a single density contrast; whereas, there are several density contrasts that contribute to the form of the residual anomaly.

A contour map showing the thickness of alluvial fill, based on the results of the inversion program, is shown in Drawing 2. The density contrast between alluvium and bedrock used in this analysis was 0.5 g/cm^3. There is very little independent information with which to compare this interpretation. One well, 7N-63E-14ab, was drilled into limestone at a depth of 370 feet (113 m) (Ertec, 1981c). Its location is noted in Drawing 2.

There are three principal sources of error in this analysis. First, because there is no detailed study of the actual densities of rocks in the area, we have had to rely on estimates. Second, the inverse modeling program, upon which most of the thickness of alluvium interpretation is based, is capable of handling only a single density contrast; whereas, there are probably several density contrasts which contribute to the residual anomaly. Third, the distribution of gravity data is not uniform, leaving large areas in which all of the interpretation is based on interpreted or extrapolated trends of the data.

4.4 DISCUSSION OF RESULTS

For purposes of discussion, Cave Valley is divided into a southern part and a northern part. The division between these two areas is a line between Shingle Pass in the Egan Range and Patterson Pass in the Schell Creek Range (Figure 2). The reason for the division was two-fold. First, the gravity data in the southern area are relatively uniformly distributed, while the northern area has several large gaps in the data. Second, both the CBA (Drawing 1) and the residual anomaly contours in the southern area tend to follow the shape of the mountain ranges and valley, while this simple pattern disappears completely in the northern area.

The interpreted structure of the southern part of Cave Valley is shown in the thickness of alluvium contour map (Drawing 2). This interpretation is based on geological information from published reports, analysis of aerial photographs (Ertec, 1981a),

and geological field reconnaissance as well as gravity data. For example, wherever sufficient gravity data existed, the placement of faults could be guided by the maximum horizontal gravity gradients (zero second vertical derivative). However, in areas lacking detailed gravity data, faults were based entirely on geologic data. Major faults shown in Drawing 2 may actually be systems of smaller faults. This is particularly true near the ends of major faults which typically dissipate through systems of smaller faults into a nearly continuous deformation.

Drawing 2 shows that the southern part of Cave Valley has a relatively simple structure. It is basically an alluvial-filled graben that retains a nearly constant width from north to south. It is slightly deeper in the extreme southern part where as much as 7000 feet (2134 m) of alluvium may overly the bedrock. The gravity data and geology both indicate that the graben is tilted down slightly to the east. The depth contours in Drawing 2 rise much more slowly on the west side of the valley than they do on the east side of the valley.

The interpretation of the Bouguer anomaly in northern Cave Valley is somewhat complicated. The fact that the gravity contours no longer follow the mountain ranges is a reflection of structure in the basement rocks and also of very shallow alluvium through most of this part of the valley. Outcrops of Cambrian age basement through the alluvium in places further substantiates that the alluvium is thin. Furthermore, the appearance of lower Cambrian sedimentary rocks at the surface in the Schell

Creek Range shows that the block making up the mountain range, and perhaps part of the block beneath the alluvium as well, does not contain the younger Paleozoic carbonate rocks found elsewhere in the region (Shilling and Garside, 1968). The loss of this high-density section of rocks causes the east-west trend of the gravity contours in northern Cave Valley.

Drawing 2 shows three inferred faults in northern Cave Valley. The inferred fault on the west side of the valley was placed on the basis of the juxtaposition of Cambrian and Permian sediments. The inferred fault on the east side of the valley was placed on the basis of aerial photos and field mapping (Howard, 1978). The only indication of either of these faults on the gravity contour map is the small gravity low enclosed by the -215 mgal contour on the east side of the valley (Drawing 1). The bend of the CBA contours in the central part of the valley correlate well with Kellogg's (1964) placement of the Shingle Pass fault.

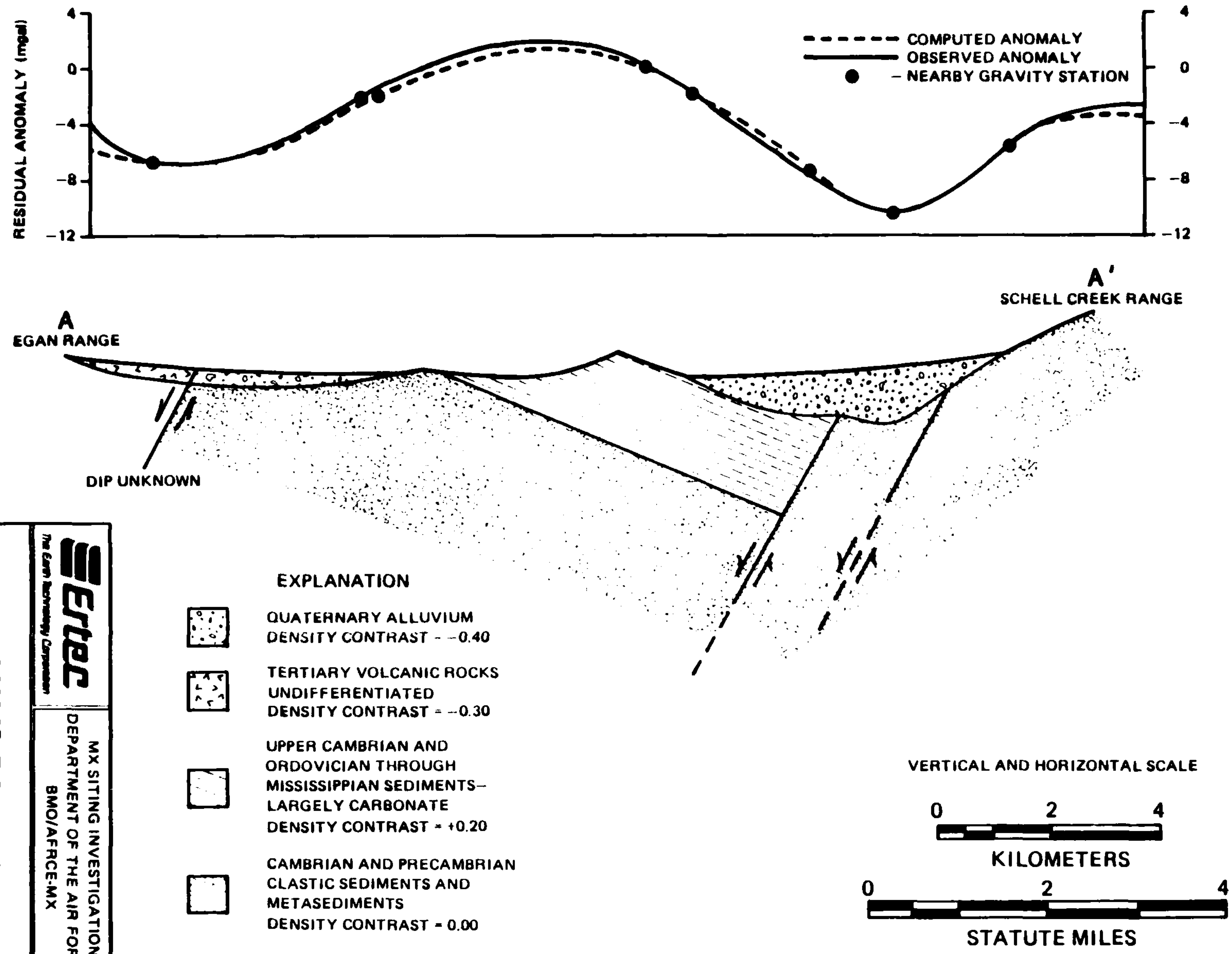
On the west side of the valley, the absence of any expression of faulting in the gravity data is probably caused by a lack of data. The lack of clear expression of faulting on the east side of the valley is caused more than anything else by a lack of density contrast across the fault which is another indication that Paleozoic carbonates are absent beneath much of the alluvium.

The small gravity low on the east side of northern Cave Valley was integrated to estimate the mass deficiency that causes it

(Grant and West, 1965). The integration resulted in a mass deficiency of 2.27×10^9 tons (2.5×10^{12} kg). If one assumes that this deficiency is caused by alluvium having a density contrast of 0.4 g/cm^3 with the Cambrian bedrock, one may conclude that the average depth of alluvium on the east side of the valley near the mountain front is about 1017 feet (310 m).

Figure 3 shows a gravity profile and interpreted cross section that crosses the northern part of the valley along section A-A' (Drawing 1). The calculations were made from a three-dimensional model of the subsurface. Figure 4 shows a more schematic cross-section across southern Cave Valley (profile B-B' in Drawing 1).

Because most of the gravity data in northern Cave Valley lie in its southern part, we have not attempted any interpretations of the extreme northern part of the valley. However, the gravity data that are available near the boundary between Cave Valley and Steptoe Valley indicate that there is probably more alluvial fill in the extreme northern part of Cave Valley than in the southern part of northern Cave Valley.



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CROSS-SECTION A–A'
CAVE VALLEY, NEVADA

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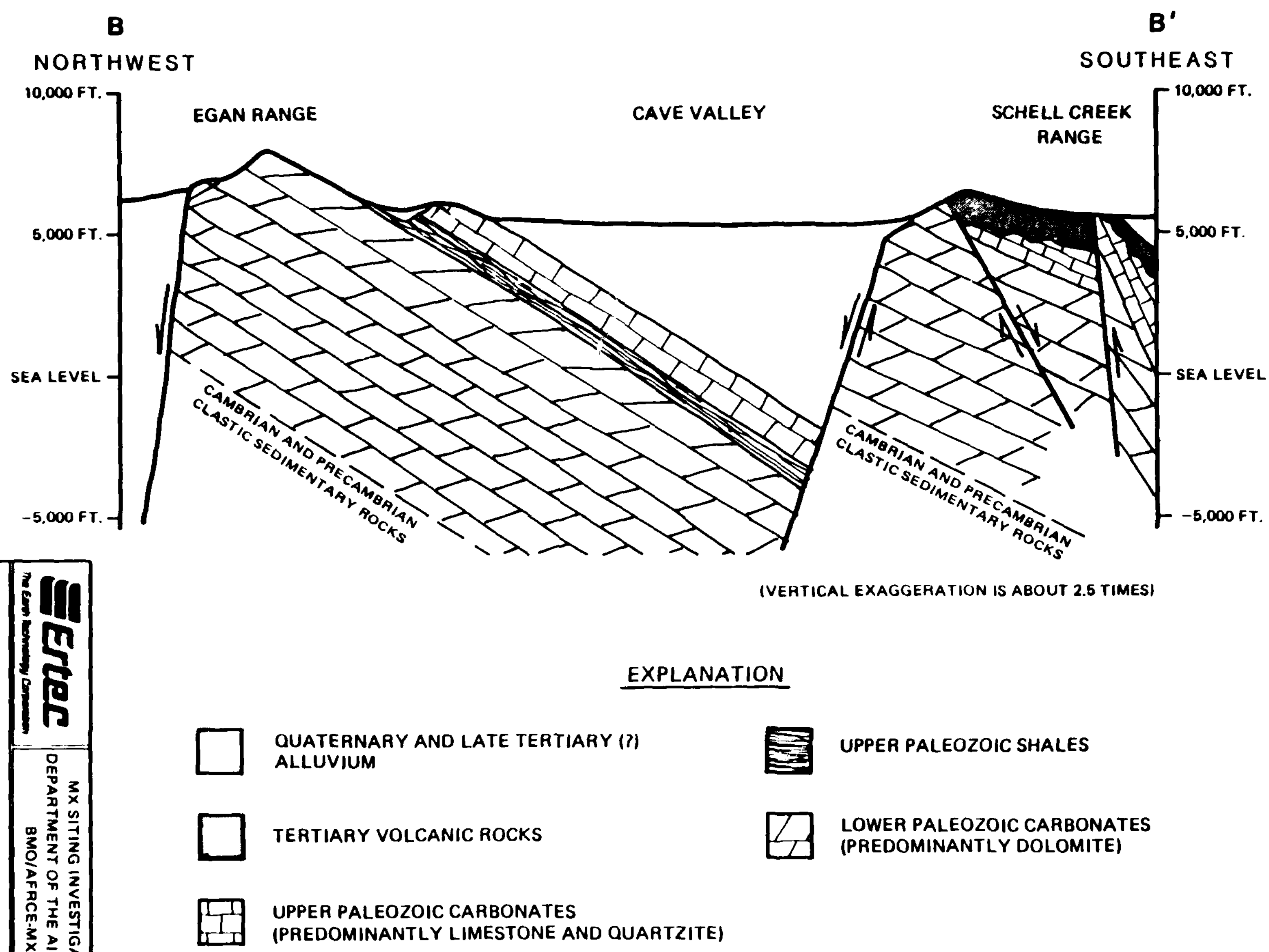
FIGURE 3



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GENERALIZED GEOLOGIC
CROSS-SECTION B–B'
SOUTHERN CAVE VALLEY, NEVADA

14 SEPT 81

FIGURE 4

5.0 CONCLUSIONS

Gravity data indicate that Cave Valley may be divided into two structurally distinct regions. That part of Cave Valley lying south of a line connecting Shingle Pass in the Egan Range with Patterson Pass in the Schell Creek Range displays a structure that is common among Basin and Range province valleys. This southern part of Cave Valley is an elongated north to north-northeast trending graben that is filled with approximately 7000 feet (2134 m) of alluvium. There is some indication in both the gravity and geology that the block constituting the graben is tilted slightly to the east.

In contrast, the northern part of Cave Valley is a rather complex structure of faulted blocks of bedrock that are relatively shallow. There is an average of 1000 feet (310 m) of alluvium on the eastern side of northern Cave Valley and about 650 feet (200 m) of alluvium on the western side of northern Cave Valley. Bouguer anomaly values in extreme northern Cave Valley indicate that the alluvium may be somewhat thicker in this area. However, the Bouguer anomaly in this area could also reflect Paleozoic carbonate rocks in the nearby mountains. The section of Paleozoic carbonate rocks is missing in the Schell Creek Range on the east side of northern Cave Valley. The carbonates probably are missing also beneath the alluvium throughout parts of northern Cave Valley.

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APPENDIX A1.0

GENERAL PRINCIPLES OF GRAVITY REDUCTION

A1.0 GENERAL PRINCIPLES OF GRAVITY REDUCTION

A1.1 GENERAL

A gravity survey involves measurement of differences in the gravitational field between various points on the earth's surface. The gravitational field values being measured are the same as those influencing all objects on the surface of the earth. They are generally associated with the force which causes a 1 gm mass to be accelerated at 980 cm/sec^2. This force is normally referred to as a 1-g force.

Even though in many applications the gravitational field at the earth's surface is assumed to be constant, small but distinguishable differences in gravity occur from point to point. In a gravity survey, the variations are measured in terms of milligals. A milligal is equal to 0.001 cm/sec^2 or 0.00000102 g. The differences in gravity are caused by geometrical effects, such as differences in elevation and latitude, and by lateral variations in density within the earth. The lateral density variations are a result of changes in geologic conditions. For measurements at the surface of the earth, the largest factor influencing the pull of gravity is the density of all materials between the center of the earth and the point of measurement.

To detect changes produced by differing geological conditions, it is necessary to detect differences in the gravitational field as small as a few milligals. To recognize changes due to

geological conditions, the measurements are "corrected" to account for changes due to differences in elevation and latitude.

Given this background, the basic concept of the gravitational exploration method, the anomaly, can be introduced. If, instead of being an oblate spheroid characterized by complex density variations, the earth were made up of concentric, homogeneous shells, the gravitational field would be the same at all points on the surface of the earth. The complexities in the earth's shape and material distribution are the reason that the pull of gravity is not the same from place to place. A difference in gravity between two points which is not caused by the effects of known geometrical differences, such as in elevation, latitude, and surrounding terrain, is referred to as an "anomaly."

An anomaly reflects lateral differences in material densities. The gravitational attraction is smaller at a place underlain by relatively low density material than it is at a place underlain by a relatively high density material. The term "negative gravity anomaly" describes a situation in which the pull of gravity within a prescribed area is small compared to the area surrounding it. Low-density alluvial deposits in basins such as those in the Nevada-Utah region produce negative gravity anomalies in relation to the gravity values in the surrounding mountains which are formed by more dense rocks.

The objective of gravity exploration is to deduce the variations in geologic conditions that produce the gravity anomalies identified during a gravity survey.

A1.2 INSTRUMENTS

The sensing element of a LaCoste and Romberg gravimeter is a mass suspended by a zero-length spring. Deflections of the mass from a null position are proportional to changes in gravitational attraction. These instruments are sealed and compensated for atmospheric pressure changes. They are maintained at a constant temperature by an internal heater element and thermostat. The absolute value of gravity is not measured directly by a gravimeter. It measures relative values of gravity between one point and another. Gravitational differences as small as 0.01 milligal can be measured.

A1.3 FIELD PROCEDURES

The gravimeter readings were calibrated in terms of absolute gravity by taking readings twice daily at nearby USGS gravity base stations. Gravimeter readings fluctuate because of small time-related deviations due to the effect of earth tides and instrument drift. Field readings were corrected to account for these deviations. The magnitude of the tidal correction was calculated using an equation suggested by Goguel (1954):

$$C = P + N\cos\phi\,(\cos\phi + \sin\phi) + S\cos\phi\,(\cos\phi - \sin\phi)$$

where C is the tidal correction factor, P, N, and S are time-related variables, and ϕ is the latitude of the observation point. Tables giving the values of P, N, and S are published annually by the European Association of Exploration Geophysicists.

The meter drift correction was based on readings taken at a designated base station at the start and end of each day. Any difference between these two readings after they were corrected for tidal effects was considered to have been the result of instrumental drift. It was assumed that this drift occurred at a uniform rate between the two readings. Corrections for drift were typically only a few hundredths of a milligal. Readings corrected for tidal effects and instrumental drift represented the observed gravity at each station.

A1.4 DATA REDUCTION

Several corrections or reductions are made to the observed gravity to isolate the portion of the gravitational pull which is due to the crustal and near-surface materials. The gravity remaining after these reductions is called the "Bouguer Anomaly." Bouguer Anomaly values are the basis for geologic interpretation. To obtain the Bouguer Anomaly, the observed gravity is adjusted to the value it would have had if it had been measured at the geoid, a theoretically defined surface which approximates the surface of mean sea level. The difference between the "adjusted" observed gravity and the gravity at the geoid calculated for a theoretically homogeneous earth is the Bouguer Anomaly.

Four separate reductions, to account for four geometrical effects, are made to the observed gravity at each station to arrive at its Bouguer Anomaly value.

a. <u>Free-Air Effect</u>: Gravitational attraction varies inversely as the square of the distance from the center of the earth. Thus, corrections must be applied for elevation. Observed gravity levels are corrected for elevation using the normal vertical gradient of:

$$FA = -0.09406 \text{ mg/ft } (-0.3086 \text{ milligals/meter})$$

where FA is the free-air effect (the rate of change of gravity with distance from the center of the earth). The free-air correction is positive in sign since the correction is opposite the effect.

b. <u>Bouguer Effect</u>: Like the free-air effect, the Bouguer effect is a function of the elevation of the station, but it considers the influence of a slab of earth materials between the observation point on the surface of the earth and the corresponding point on the geoid (sea level). Normal practice, which is to assume that the density of the slab is 2.67 grams per cubic centimeter, was followed in these studies. The Bouguer correction (B_c), which is opposite in sign to the free-air correction, was defined according to the following formula.

$$B_c = 0.01276\ (2.67)\ h_f \text{ (milligals per foot)}$$

$$B_c = 0.04185\ (2.67)\ h_m \text{ (milligals per meter)}$$

where h_f is the height above sea level in feet and h_m is the height in meters.

c. <u>Latitude Effect</u>: Points at different latitudes will have different values of gravity for two reasons. The earth (and the geoid) is spheroidal, or flattened at the poles. Since

points at higher latitudes are closer to the center of the earth than points near the equator, gravity at the higher latitudes is larger. As the earth spins, the centrifugal acceleration causes a slight decrease in the measured value of gravity. At the higher latitudes where the earth's circles of latitude are smaller, the centrifugal acceleration diminishes. The gravity formula for the Geodetic Reference System, 1967, gives the theoretical value of gravity at the geoid as a function of latitude. It is:

$$g = 978.0381\ (1 + 0.0053204 \sin^2 \phi - 0.0000058 \sin^2 2\phi)\ \text{gals}$$

where g is the theoretical acceleration of gravity and ϕ is the latitude in degrees. The positive term accounts for the spheroidal shape of the earth. The negative term adjusts for the centrifugal acceleration.

The previous two corrections (free air and Bouguer) adjust the observed gravity to the value it would have at the geoid (sea level). The theoretical value at the geoid for the latitude of the station is subtracted from the adjusted observed gravity and the remainder is called the Simple Bouguer Anomaly (SBA). Most of this represents the effect of material beneath the station, but part of it may be due to irregularities in terrain (upper part of the Bouguer slab) around the station.

d. Terrain Effect: Topographic relief around the station has a negative effect on the gravitational force at the station. A nearby hill has upward gravitational pull and a nearby valley contributes less downward attraction than a nearby material

would have. Therefore, the corrections are always positive. Corrections are made to the SBA when the terrain effects are 0.1 milligal or larger. Terrain corrected Bouguer values are called the Complete Bouguer Anomaly (CBA). When the CBA is obtained, the reduction of gravity at individual measurement points (stations) is complete.

APPENDIX A2.0

METHODS OF INTERPRETATION

A2.0 METHODS OF INTERPRETATION

A2.1 REGIONAL - RESIDUAL SEPARATION

To interpret the gravity data, the portion of the CBA that might be caused by the light-weight, basin-fill material must be separated from that caused by the heavier bedrock material which forms the surrounding mountains and presumably the basin floor. The first step is to estimate a regional field. This is an estimation of the values the CBA would have if the light-weight sediments (the anomaly) were not there. Since the valley-fill sediments are absent at the stations read in the mountains, one approach is to use the CBA values at bedrock stations as the basis for constructing a second order polynomial surface to represent a regional field over the valley.

Where there are insufficient bedrock stations to define a satisfactory regional trend, another approach is to estimate the regional by the process of upward continuation of the CBA field. A principal result of potential field theory is that a field quantity satisfying Laplace's equation in a three-dimensional volume of space is specified completely by the value it has on the surface bounding that volume (Grant and West, 1965). Since the gravitational field satisfies Laplace's equation, its value anywhere above the surface of the earth can be found using only the value of gravity on the surface of the earth, regardless of the mass distribution that produces the value of gravity in the first place. On this basis, the Bouguer anomaly is readil continued to level surfaces above the ground.

An important property of upward continuation is that the resultant field (which can be represented by a contour map), changes more with respect to shallow sources than it does with respect to deeper sources. The anomalous parts of the field ascribed to shallow density distribution tend to vanish as the continuation is carried upward; whereas the field produced by deeper sources changes only slightly, so that upward continuation produces regional-type fields.

The difference between the CBA and the regional field is called the residual field or residual anomaly. The residual field is the interpreter's estimation of the gravitational effect of the geologic anomaly.

A2.2 INTERPRETATION OF THE RESIDUAL ANOMALY

If the regional is well chosen, the magnitude of the residual anomaly is a function of the thickness of the anomalous (fill) material and the density contrast. The density contrast is the difference in density between the alluvial and bedrock material. If this contrast were known exactly, an accurate calculation of the thickness could be made. Generally, the densities are not well known and vary within the study area. Therefore, it is necessary to use densities typical of materials similar to those in the study area.

If the selected average density contrast is smaller than the actual density contrast, the computed depth to bedrock will be greater than the actual depth and vice-versa. The computed depth is inversely proportional to the density contrast. A ten

percent error in density contrast produces a ten percent error in computed depth.

Once the density contrast between the alluvium and bedrock is established, there are several methods available for determining the form of the alluvium-bedrock interface. One way is to use an iterative computer program which will yield some simple model of the interface approximately explaining the residual gravity anomaly (Cordell, 1970). An alternative approach is to assume the form of the interface a priori and, calculate what effect this would have on the residual gravity anomaly. By continually adjusting the model, one may obtain a reasonable estimate of the interface. There are computer programs that will calculate the gravitational effect of two-dimensional (Talwani et al, 1959) and three-dimensional (Plouff, 1975) bodies.

APPENDIX A3.0

CAVE VALLEY, UTAH

GRAVITY DATA

CAVE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG	MIN	LONG. DEG MIN ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0132	38	504	114511251240T	0	133421711	68839150565199947	-1180	81483
0262	38	520	114407455889T	0	138421777	70356146709199970	-680	80388
0263	38	531	114414254629T	0	132421795	70256147609199986	-990	80512
0130	38	537	114516851739T	0	120421770	68756150246199995	-1080	81470
1046	38	563	114533553369T	15	111421812	68510149123200033	-710	81216
1047	38	563	114543754659T	9	93421809	68361148252200033	-360	81092
0282	38	564	114427452881T	0	136421851	70061149557200035	-730	81366
0275	38	593	114402556280T	0	145421914	70424146313200077	-820	80125
0129	38	601	114515151699T	0	102421889	68778150053200089	-1400	81072
0278	38	602	114417554062T	0	128421925	70204147913200090	-1320	80368
0128	38	603	114524152431T	0	124421890	68646150008200092	-760	81484
0144	38	619	114503450869T	0	106421926	68948150239200115	-2020	80736
7413	38	620	114507851401T	0	96421926	68884149884200117	-1880	80686
5029	38	622	114413254511T	0	137421963	70266147426200120	-1410	80137
0294	38	623	114449152500T	0	121421952	69741149611200121	-1120	81091
0274	38	627	114406255600T	0	135421975	70368146706200127	-1120	80055
1914	38	640	114489250951T	0	92421970	69155149925200146	-2290	80422
0157	38	658	114478351161T	0	96422007	69313149692200172	-2350	80296
0154	38	675	114467551801T	0	101422042	69470149198200197	-2270	80161
0127	38	676	114513451601T	0	106422028	68799149767200199	-1890	80616
0146	38	695	114500351129T	0	101422049	68990150015200212	-2100	80561
0297	38	657	114423755000T	0	122422080	70110147246200215	-1230	80132
1051	38	691	114537954301T	0	140422048	68441148380200221	-760	80860
0158	38	692	114456152530T	0	107422078	69636149307200222	-1500	80687
0126	38	700	114523252999T	0	125422069	68655149385200234	-990	81055
0295	38	705	114443353930T	0	123422106	69822148584200241	-920	80803
0296	38	710	114432055230T	0	129422119	69987147473200248	-820	80469
7412	38	710	114441153930T	0	127422116	69854148611200248	-900	80837
7414	38	710	114579053770T	0	98422069	67839147808200248	-1850	79908
0276	38	711	114412156220T	0	121422128	70278146571200250	-790	80151
1053	38	715	114554055620T	0	100422087	68204147761200256	-170	80960
0145	38	716	114505751401T	0	105422105	68910149825200257	-2080	80495
0156	38	721	114476051709T	0	105422124	69344149708200265	-1910	80555
1052	38	743	114545755659T	0	130422141	68325147945200297	0	81160
0008	38	751	114450555479T	0	113422189	69715147515200308	-600	80593
0781	38	761	114430357749T	0	126422214	70010146652200323	650	81086
0780	38	762	114438556181T	0	107422213	69890146994200325	-480	80467
0001	38	767	114523453770T	0	127422193	68649148277200332	-1470	80317
0782	38	771	114422556270T	0	124422236	70123146360200338	-1040	79884
0002	38	771	114511752251T	0	107422204	68820149331200338	-1850	80437
1006	38	776	114574855371T	0	101422193	67898146936200345	-1320	79901

CAVE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN ELEV. +CODE	TER-COR. IN/OUT NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0003	38 793	114501551591T	0 103422249	68968149789200370	-2050	80463
1014	38 803	114552057221T	0 125422250	68230146962200385	400	81015
1020	38 805	114528954869T	0 131422262	68567148040200387	-730	80691
0784	38 807	114442158560T	0 147422295	69835145467200390	160	80337
0005	38 808	114485256339T	0 197422282	69206147010200392	-380	80597
0783	38 815	114427456870T	0 126422315	70050146386200402	-520	80216
0785	38 819	114449157021T	0 122422315	69733146525200408	-240	80432
0004	38 833	114499751509T	0 119422323	68993149882200428	-2090	80459
0015	38 848	114519953852T	0 109422344	68697149039200450	-750	80989
1011	38 853	114569357881T	0 114422337	67975146242200458	220	80604
0009	38 861	114455056650T	0 115422391	69645146898200469	-280	80515
1021	38 864	114531055600T	0 163422370	68534147616200474	-550	80643
1007	38 864	114574956781T	0 113422356	67893146576200474	-480	80263
0014	38 869	114511853041T	0 110422386	68814148763200481	-1820	80200
0786	38 873	114435257470T	0 122422420	69933146343200487	-80	80442
1013	38 874	114557459029T	0 138422380	68148145804200489	830	80848
0010	38 880	114467256001T	0 112422421	69465147321200497	-500	80512
0800	38 892	114427660341T	0 149422458	70043144701200515	940	80519
0011	38 892	114477355840T	0 111422440	69317147348200515	-640	80431
0012	38 899	114489852510T	0 105422449	69135149678200525	-1450	80745
1022	38 906	114536258520T	0 136422446	68457146046200535	550	80736
0013	38 914	114499951860T	0 132422473	68986149911200547	-1850	80592
0787	38 922	114444556850T	0 135422507	69795146689200559	-390	80355
1010	38 928	114565558911T	0 138422477	68028145884200568	720	80778
0016	38 929	114519554380T	0 122422494	68699148252200569	-1160	80412
0018	38 939	114493455850T	0 152422521	69080147262200584	-780	80322
1016	38 942	114552061499T	0 152422507	68224144400200588	1660	80842
0020	38 944	114466958261T	0 131422540	69467145919200591	120	80391
0021	38 946	114455859341T	0 175422547	69629145187200594	410	80355
1008	38 952	114574958150T	0 126422518	67889146188200603	280	80576
0017	38 955	114511653540T	0 126422545	68814148614200607	-1630	80236
0804	38 963	114432361171T	0 163422587	69971144694200619	1610	80923
0019	38 966	114483754692T	0 94422575	69221148305200623	-870	80574
0022	38 991	114457258471T	0 119422630	69607145899200660	230	80419
0803	38 997	114440060732T	0 150422647	69857144782200669	1230	80680
1024	38 998	114540860390T	0 174422615	68385144723200670	850	80444
1015	381001	114557861440T	0 173422615	68137144667200674	1780	81003
0026	381003	114498252251T	0 128422638	69007149740200677	-1780	80518
0805	381005	114426366581T	0 386422667	70057141111200680	3050	80736
0027	381011	114512854239T	0 123422648	68794149365200689	-1300	80323
0028	381012	114522355801T	0 136422647	68655147801200691	-400	80706

CAVE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN ELEV. +CODE	TER-COR. IN/OUT	NORTH UTM	EAST UTM OBSV GRAV THEO GRAV	FAA	CBA +1000
0024	381013	114475254491T	0	128422665	69343148398200692	-1030	80508
1009	381023	114571563711T	0	264422651	67936143085200707	2300	80844
0023	381024	114465856280T	0	97422688	69480147015200708	-750	80147
0025	381034	114487656319T	0	111422699	69161146865200723	-880	80021
7442	381055	114436860397T	0	140422756	69902145498200754	1550	81110
0819	381068	114442559531T	0	125422778	69818145722200773	940	80775
0032	381074	114476256969T	0	114422777	69325146449200781	-740	79944
0034	381079	114457057110T	0	103422793	69606147198200789	120	80763
0033	381084	114467255341T	0	100422799	69456147848200796	-890	80340
0031	381090	114495752710T	0	126422800	69040149004200805	-2210	79936
0030	381104	114506954449T	0	128422822	68876148526200825	-1080	80478
0820	381149	114443961680T	0	161422927	69794143784200891	910	80041
7415	381220	114599056539T	0	96423006	67527147065200995	-740	80076
7440	381410	114483853960T	0	132423396	69200147951201274	-2560	79172
7444	381490	114558260052T	0	118423519	68111146003201391	1090	80748
7441	381515	114422060843T	0	121423612	70097144428201427	220	79611
7443	381775	114496062487T	0	191424067	69006145059201808	2020	80921
7424	381825	114419059551T	0	195424186	70126145228201882	-630	79255
7423	382020	114433557799T	0	273424542	69906146055202168	-1730	78823
7418	382100	114504059911T	0	206424665	68875146994202285	1060	80846
7221	382105	114504059918T	0	198424674	68875146990202292	1050	80828
7281	382305	114548259790T	0	201425029	68223147365202586	1000	80831
7283	382535	114433862221T	0	169425494	69878144719202923	320	79289
7419	382545	114486560312T	0	135425494	69111147334202938	1120	80705
7220	382550	114486560285T	0	134425503	69110147335202945	1090	80684
H611	382691	114589058930T	0	337425730	67613148696203152	970	81227
7282	382835	114526060105T	0	220426017	68523147369203363	530	80270
7285	383050	114408062087T	0	162426456	70229145480203679	190	79192
7420	383050	114477260840T	0	152426431	69224146340203679	-110	79292
7267	383032	114501660659T	0	215426482	68868147295203726	610	80165
7269	383094	114597355551T	0	223426473	67476149877203744	-1610	79673
H231	383111	114585857710T	0	391426508	67643149200203769	-280	80441
5027	383207	114476561152T	0	169426722	69227146145203910	-230	79079
785	383344	114548567779T	0	301426951	68175142323204111	1960	79161
H148	383428	114592060157T	0	241427092	67540147768204234	120	79861
7421	383515	114476562251T	0	196427292	69213145917204362	100	79086
7268	383533	114546269091T	0	209427301	68200141652204389	2240	78909
7219	383570	114435074003T	0	543427408	69813138963204443	4120	79443
7422	383590	114425569649T	0	472427430	69951141483204458	2530	79262
5026	383602	114480262671T	0	196427451	69156146082204490	530	79376
7270	383675	114518566119T	0	147427573	68596144109204597	1690	79307

CAVE VALLEY GRAVITY DATA

STATION IDENT.	LAT. DEG MIN	LONG. DEG MIN / ELEV. +CODE	TER-COR. IN/OUT / NORTH UTM	EAST UTM / OBSV GRAV / THEO GRAV	FAA	CBA +1000
7291	383805	114430089934T	01445427845	69875128318204788	8110	78905
N761	383838	114489364137T	0 212427977	69011145330204910	750	79102
7271	383908	114533668980T	0 195427999	68367141616204940	1550	78235
7274	383962	114483965869T	0 253428116	69086144360205019	1290	79093
5025	384159	114488769482T	0 237428479	69008142205205309	2250	78807
N760	384286	114504666457T	0 208428708	68772143802205496	820	78378
7272	384330	114545572749T	0 265428776	68177141146205560	4010	79485
7208	384400	114505767310T	0 214428919	68751143369205663	1010	78284
LV0162	382636	1144012 8860V	463635425785	70345127201203145	7461	80923
CAV021	383599	1144473 8426C	592307427457	69633131241204486	6072	79699
CAV023	383492	1144381 9145C	813513427263	69772125213204328	6973	79376
CAV022	383558	114440672339T	0 585427384	69732139887204425	3551	79463
CAV051	382756	1145674 8152C	242173425857	67925133699203247	7188	81580
CAV052	382694	1145498 6176B	0 259425748	68183146593203156	1564	80759
CAV057	382481	1145375 5978S	0 123425359	68371146628202844	47	79781
CAV073	382274	1144861 7406C	322236424993	69128137344202540	4514	81522
CAV075	382379	114487560420T	0 241425224	69102147125202724	1267	80901
CAV086	382676	1144560 7383V	38 951425747	69549137667203130	4030	79838
CAV093	382030	1144947 8114C	673245424539	69014131891202182	6086	81724
CAV099	381806	1145153 7745V	402034424117	68723134750201854	5799	81457
LV0041	384006	1144310 9695C	252229428216	69851123336205084	9522	78709
LV0064	383142	1144376 8266C	241706426616	69795132536203814	6532	80069
CAV120	383404	1144938 6921C	12 620427080	68967142337204199	3280	80306
CAV039	383629	1144940 7229S	451087427497	68954139822204530	3335	79811
CAV028	383532	1144563 6635S	0 371427330	69506143642204387	1704	79445
CAV026	383238	1144565 6503B	0 375426879	69514144433204029	1610	79806
CAV001	383902	1145495 7382C	8 292427983	68137139111204931	3663	78785
CAV020	383849	1144466 8535S	251127427920	69632131765204853	7254	79296
CAV024	383212	1144424 8263C	441580426743	69722132481203917	6345	79786
CAV049	383426	1145394 7166C	4 234427106	68304140161204231	3379	79176
CAV085	382461	1144769 7048C	94 573425342	69254139556202814	3080	79708
CAV089	382998	1145245 6555C	14 343426319	68538144797203603	2891	80890
CAV108	381590	1145462 6559V	6 245423689	68282143125201523	3337	81217
CAV114	382233	1145652 7252V	22 630424891	67978139429202480	5209	81126
CAV118	382029	1145739 7418C	19 810424511	67860137859202181	5501	81030
CAV119	382511	1145613 7023C	11 482425406	68024141167202888	4382	80921
CAV007	384186	1145173 6845C	3 173428519	68592142397205349	1474	78304
CAV048	383644	1145398 7100C	2 219427509	68289140547204552	2824	78829
CAV116	381796	1145701 6563C	3 220424081	67925142624201839	2556	80394
CAV015	384139	1144840 7256C	29 337428443	69077140254205279	3271	78889
CAV047	383235	1145194 8365C	61313426852	68600132979204024	7697	80485

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LV0035	384254	1144276	7695C	4 649428676	69889137093205449	4076	78483
LV0059	383377	1144300	7319C	14 403427053	69895139199204159	3930	79384
LV0156	382696	1144382	7574C	16 591426160	69797137075203453	4914	79688
LV0165	382428	1144070	7048C	6 347425306	70273141407202766	4979	81293
LV0170	382090	1144031	8613C	122214424682	70345128958202270	7766	80615
LV0293	383714	1144147	6897C	17 483427682	70101141784204655	2046	79022
CAV002	384004	1145348	69373	0 209428176	68346141603205081	1815	78364
CAV003	383827	1145379	7008C	0 200427848	68308141336204821	2477	78775
CAV004	383791	1145202	6703C	0 158427787	68567143514204768	1836	79132
CAV005	383927	1145206	6777S	0 166428039	68555142902204968	1721	78772
CAV006	384057	1145248	6975C	0 188428278	68489141397205159	1889	78287
CAV008	384094	1145026	6587S	0 173428354	68809143859205213	643	78349
CAV009	383959	1145054	6624C	0 153428103	68774143809205015	1140	78701
CAV010	383824	1145054	6541S	0 146427853	68780144389204816	1136	78973
CAV011	383760	1144974	6441S	0 162427738	68899145264204722	1164	79357
CAV012	383829	1144878	6384S	0 204427869	69035145478204824	740	79170
CAV013	383961	1144838	6587S	0 253428114	69087144332205018	1311	79098
CAV014	384041	1144899	6788C	0 219428260	68995143347205135	2101	79168
CAV016	384044	1144726	7129C	0 379428272	69246140687205140	2648	78712
CAV017	383870	1144726	6724C	0 304427950	69254143393204884	1796	79166
CAV018	383785	1144612	6816C	0 422427797	69423141887204759	1281	78456
CAV019	383960	1144615	7500C	0 576428120	69411138129205016	3708	78703
CAV025	383099	1144556	6720C	0 325426530	69535143299203751	2798	80203
CAV027	383418	1144576	6499B	0 305427119	69492144061204220	1010	79148
CAV029	383648	1144537	68232	0 653427546	69538141022204558	684	78065
CAV030	383654	1144697	6404B	0 261427551	69306144766204566	474	78893
CAV031	383529	1144733	6237C	0 210427319	69259145853204383	172	79109
CAV032	383342	1144724	6168S	0 190426973	69280145984204108	-72	79080
CAV033	383175	1144695	6145C	0 188426665	69330146012203863	-15	79214
CAV034	383013	1144704	6087B	0 183426365	69324146299203625	-36	79386
CAV035	383110	1144835	6077B	0 155426540	69129146323203767	-249	79179
CAV036	383226	1144801	6120B	0 167426756	69174146311203938	-27	79266
CAV037	383429	1144799	6207B	0 179427132	69168146308204236	492	79500
CAV038	383661	1144859	63363	0 204427559	69070145839204577	896	79490
CAV040	383538	1144891	6301B	0 174427330	69029145953204396	861	79544
CAV041	383357	1144876	6185C	0 209426996	69059146667204130	749	79862
CAV042	383226	1144909	6107C	0 212426752	69017146915203938	456	79838
CAV043	383113	1144995	6071B	0 226426540	68897147289203772	656	80176
CAV045	383550	1145076	6444B	0 163427346	68760145550204414	1787	79971
CAV046	383631	1145179	6559B	0 150427492	68607144451204533	1652	79431
CAV054	382377	1145553	6204B	0 274425197	68116146123202721	1793	80907

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CAV055	382307	1145372	5970S	0	117425037	68383146312202589	-89	79666
CAV056	382374	1145442	5975S	0	143425195	68277147201202716	720	80484
CAV058	382581	1145384	5984C	0	142425543	68354147085202991	414	80146
CAV059	382683	1145332	6005C	0	159425734	68425147286203140	663	80341
CAV060	382567	1145261	5983S	0	117425521	68533146247202970	-413	79297
CAV061	382394	1145262	5970S	0	105425201	68539145526202716	-1003	78740
CAV062	382307	1145151	5971S	0	101425044	68705145043202589	-1349	78387
CAV063	382482	1145154	5978S	0	102425368	68693144924202845	-1658	78055
CAV064	382650	1145173	5990S	0	118425678	68658145839203092	-877	78811
CAV065	382754	1145127	6004S	0	129425872	68720146111203245	-626	79025
CAV066	382820	1145238	6012C	0	193425990	68556147358203341	600	80288
CAV067	382905	1145150	6025S	0	193426150	68680147234203466	474	80117
CAV068	382993	1145055	6043C	0	189426316	68815146882203595	162	79740
CAV069	382859	1145030	6020S	0	134426069	68857145749203399	-991	78610
CAV070	382764	1144992	6010S	0	114425895	68916145314203259	-1381	78234
CAV071	382569	1145045	5986S	0	106425532	68848144886202973	-1749	77941
CAV072	382395	1145041	5976S	0	103425211	68861144904202718	-1569	78151
CAV074	382317	114491760321T		0	176425071	69045146861202603	1030	80632
CAV076	382482	1144933	5981S	0	117425375	69014145982202845	-573	79145
CAV077	382572	1144950	5990S	0	109425541	68986145549202977	-1053	78626
CAV078	382668	1144947	6001C	0	111425719	68986145434203118	-1205	78438
CAV079	382739	1144886	6018S	0	121425945	69069145451203296	-1205	78390
CAV080	382695	1144903	6030S	0	127426140	69040145273203451	-1426	78134
CAV081	382983	1144868	6043S	0	138426304	69087145588203581	-1118	78409
CAV082	382835	114476260420T		0	154426127	69245146084203437	-487	79059
CAV083	382678	1144803	6022C	0	142425742	69195147048203133	592	80195
CAV084	382547	114484460312T		0	157425499	69141147321202941	1142	80729
CAV087	382764	1144642	6321C	0	218425907	69425145771203259	2004	80663
CAV088	382866	1144620	6401B	0	248426096	69453145279203409	2116	80532
CAV091	382196	114485061089T		0	225424849	69148146657202426	1728	81117
CAV092	382164	114495960200T		0	345424786	68990147056202379	1336	81148
CAV094	382105	114502859911T		0	223424675	68893146964202292	1057	80847
CAV095	382222	1145042	5970S	0	119424891	68867145954202464	-322	79435
CAV096	382135	1145152	5970S	0	115424726	68711145874202336	-275	79478
CAV097	382063	114512259701T		0	151424594	68757146620202231	577	80366
CAV098	381961	1145152	6042C	0	184424404	68718146531202081	1316	80892
CAV100	381856	1145243	6068C	0	185424207	68590146036201927	1219	80708
CAV101	382047	1145262	5973S	0	110424560	68554146139202207	148	79885
CAV102	382220	1145261	5970S	0	104424880	68548145529202461	-745	78997
CAV103	382133	1145371	5975S	0	113424715	68392146221202333	122	79856
CAV104	381960	1145372	5975S	0	110424395	68398146140202060	295	80026

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CAV105	381839	1145381	5990S	0 115424171	68390145759201902	233	79918
CAV106	381731	1145306	6206C	0 161423974	68503145035201744	1701	80695
CAV107	381638	1145407	6219B	0 129423798	68360145320201608	2245	81163
CAV109	381755	1145490	6170C	0 114424012	68234144998201779	1289	80359
CAV110	381836	114553760331T		0 118424197	68161146384201927	1237	80778
CAV111	381961	1145482	6010C	0 121424393	68237146502202081	986	80608
CAV112	382046	1145482	6081C	0 130424550	68234146235202206	1262	80652
CAV113	382220	1145481	6082C	0 167424872	68228146736202461	1517	80940
CAV115	381961	1145592	6158C	0 142424390	68077146094202081	1971	81110
CAV117	381891	114574463389T		0 174424255	67858144430201978	2113	80667
LV0036	384216	1144090	68292	0 358428613	70160142370205393	1253	78320
LV0042	383968	1144069	6950C	0 461428155	70202141580205028	1967	78724
LV0050	383614	1144082	6414C	0 277427499	70200144689204508	550	78951
LV0051	383568	114427369649T		0 538427407	69925141468204440	2584	79367
LV0052	383494	1144102	6330C	0 244427277	70177144640204331	-114	78540
LV0053	383456	1144010	6121C	0 184427210	70312145695204275	-971	78336
LV0058	383362	1144041	6185C	0 181427035	70271144907204137	-1018	78067
LV0060	383238	1144078	6246C	0 175426804	70223145365203955	196	79068
LV0065	383043	1144073	6204C	0 156426444	70240145462203669	184	79180
LV0154	382927	1144004	6097C	0 153426231	70346146165203499	50	79408
LV0155	382930	1144103	6220C	0 164426233	70202145257203503	296	79245
LV0157	382794	1144171	6316C	0 212425979	70109144777203303	919	79589
LV0158	382846	1144046	6246B	0 209426080	70288145570203380	977	79883
LV0167	382326	1144027	6445Y	0 206425119	70340144953202616	2997	81221
WRV242	381039	1145689	6430S	162 237422681	67973142852200730	2642	81110
MSV076	381303	1144439	5847V	23 114423212	69787145469201117	-618	79577
MSV075	381149	1144439	6168S	201 159422927	69794143805200891	966	80289
MSV055	381564	1145212	6900C	690 423423668	68648140833201499	4278	81857
CAV086	382676	1144560	7383C	238 634425747	69549137676203130	4040	79730
CAV090	382946	1144466	8269S	4051503426250	69673132228203526	6539	80244
CAV093	382030	1144947	8114C	9742209424539	69014131888202182	6084	81592
MSV013	382314	1144120	6652S	10 198425093	70205143740202599	3751	81271
MSV014	382161	1144047	8396S	5992016424813	70319130486202374	7146	81124
MSV021	381935	1144165	7396S	609 874424391	70157136904202043	4477	80734
MSV052	381849	1144961	7190C	27 787424204	69001138329201917	4088	80379
MSV057	381295	1145215	6489S	9 330423170	68655142631201105	2621	80828
MSV080	381213	1144109	7239S	22 698423057	70272136185200985	3337	79367
WRV239	381131	1145804	6147S	102 204422848	67802145087200865	2077	81417
WRV235	381350	1145702	6445Y	112 234423256	67942142936201186	2411	80775
WRV087	382029	1145739	7418C	174 812424511	67860137856202181	5498	81183
WRV090	381578	1145891	6318C	3 291423672	67657144591201520	2536	81281

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WRV248	38 627	1145745	5893C	166	313421917	67908144464200127	-200	80180
CAV026	383288	1144565	6445B	0	328426879	69514144684204029	1316	79662
CAV085	382461	1144769	7048C	0	576425342	69254139553202814	3077	79614
CAV091	382196	114485061089T		0	219424849	69148146653202426	1724	81107
MSV001	382271	1144651	6039V	0	114424995	69434145796202536	97	79614
MSV002	382330	1144664	6150C	0	131425196	69410145525202696	712	79867
MSV003	382423	1144540	6202C	0	125425280	69589144875202759	488	79460
MSV004	382295	1144515	6002C	0	114425044	69631145270202571	-812	78831
MSV005	382308	1144390	6088S	0	136425073	69813145024202590	-267	79104
MSV006	382441	1144379	6134S	0	145425319	69823144979202785	-74	79149
MSV007	382538	1144346	6230S	0	167425500	69866144692202928	401	79319
MSV008	382655	1144272	6396S	0	203425719	69968144182203099	1282	79670
MSV009	382725	1144209	6445S	0	220425850	70057144036203202	1494	79732
MSV011	382416	1144273	6338S	0	171425277	69978144376202748	1281	79835
MSV012	382235	1144276	6356C	0	179425034	69980144494202556	1760	80260
MSV017	381547	1144098	6255S	0	139423676	70273143308201474	706	79510
MSV018	381728	1144139	6310S	0	158424009	70205143858201740	1508	80144.
MSV019	381830	114412462300T		0	175424198	70222144744201889	1491	80418
MSV020	381874	114404664071T		0	203424282	70334143725201954	2074	80425
MSV022	382182	1144269	6390V	0	211424844	69995144371202405	2108	80524
MSV023	382073	1144268	6410S	0	214424642	70001144215202245	2301	80652
MSV024	381954	1144233	6347S	0	224424423	70057144075202071	1742	80318
MSV025	381843	114422861519T		0	161424218	70070144788201908	781	79959
MSV026	381645	1144218	6146B	0	124423852	70094144522201618	749	79911
MSV027	381547	1144318	5981C	0	111423668	69952144473201474	-710	79001
MSV028	381620	1144382	5899V	0	108423800	69856144698201581	-1364	78624
MSV029	381735	1144323	5964V	0	115424015	69936144709201750	-909	78864
MSV030	381874	114431260289T		0	154424310	69945144992201983	-248	79343
MSV031	381937	114438759550T		0	131424386	69834145203202046	-796	79024
MSV032	382069	1144398	6013S	0	140424630	69812145439202239	-207	79424
MSV033	382211	1144437	5997S	0	131424891	69749145132202448	-873	78804
MSV034	381817	1144465	5842V	0	112424162	69726145292201870	-1595	78591
MSV035	381680	1144483	5798S	0	104423908	69706145184201669	-1917	78412
MSV036	381592	1144556	5722V	0	103423742	69603145524201540	-2163	78424
MSV037	381557	114475255121T		0	117423671	693191470182C 489	-2595	78722
MSV038	381635	114469855571T		0	112423817	69394146756201603	-2547	78611
MSV039	381710	114465756010T		0	112423957	69450146517201713	-2483	78526
MSV040	381786	1144607	5647C	0	114424099	69520146435201825	-2243	78611
MSV041	381926	1144556	5722C	0	120424360	69588146193202030	-1984	78620
MSV042	382038	1144579	5805C	0	119424566	69550146109202194	-1450	78869
MSV043	382139	1144530	5905C	0	116424755	69616145386202342	-1360	78595

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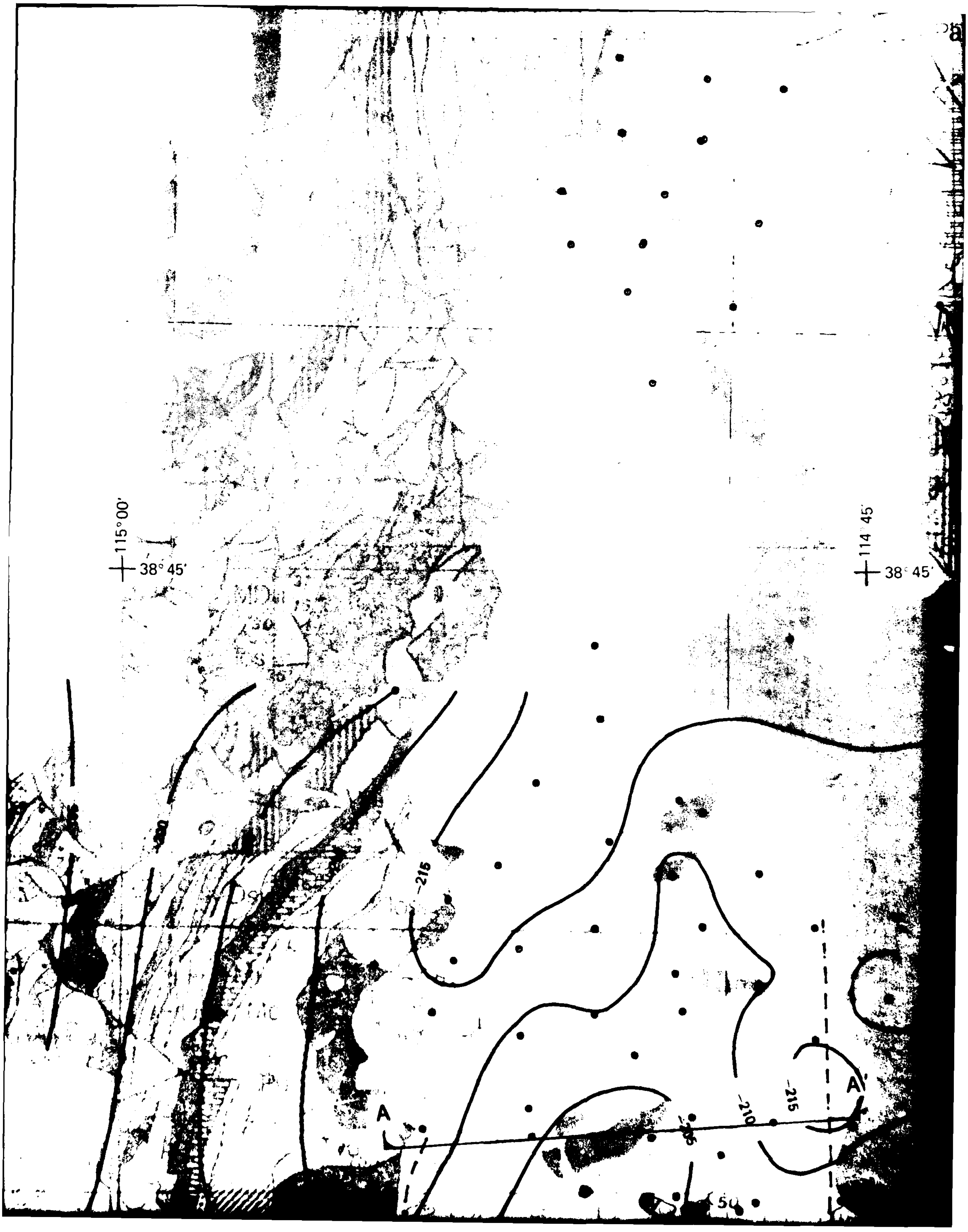
MSV044	382143	114467459130T		0	131424757	69406146282202348	-415	79548
MSV045	382191	114475160699T		0	139424843	69292146184202418	895	80331
MSV046	381951	1144691	5982C	0	143424402	69390145419202066	-347	79393
MSV047	381825	1144775	5915C	0	143424166	69273145347201882	-865	79104
MSV048	381757	1144836	5892C	0	139424038	69187145413201782	-916	79127
MSV049	381650	1144876	5782C	0	125423838	69134145983201625	-1224	79180
MSV050	381514	1144919	5595C	0	119423585	69077146995201426	-1774	79262
MSV051	381765	1144951	6110C	0	174424049	69019145440201794	1152	80487
MSV053	381655	1145033	6110V	0	179423842	68905145304201633	1178	80517
MSV054	381544	1145093	5957V	0	174423635	68822146025201470	621	80477
MSV056	381376	1145156	5890V	0	184423322	68737146250201224	461	80556
MSV058	381103	1145069	5445Y	0	125422820	68876148550200824	-1029	80525
MSV059	381219	1145037	5508V	0	135423036	68918147855200994	-1301	80048
MSV060	381295	1145003	5509Y	0	126423177	68964147453201105	-1805	79531
MSV061	381407	1144956	5552Y	0	115423386	69028147159201269	-1858	79321
MSV062	381435	1144818	5468Y	0	118423443	69228147432201310	-2416	79052
MSV063	381338	114487453970T		0	128423261	69150147931201168	-2444	79276
MSV064	381252	114490453599T		0	118423101	69110148495201042	-2103	79734
MSV065	381169	114493053271T		0	122422947	69076148650200920	-2137	79816
MSV066	381089	114495752710T		0	124422798	69040149016200803	-2181	79965
MSV067	381074	1144762	5697Y	0	113422777	69325146467200781	-697	79985
MSV068	381203	1144760	5453V	0	104423016	69323148344200970	-1306	80199
MSV069	381334	1144723	5516V	0	99423259	69371147241201162	-2007	79278
MSV070	381479	1144622	5649V	0	97423531	69512146112201375	-2096	78734
MSV071	381350	1144559	5692V	0	100423350	69608146031201230	-1628	79058
MSV072	381247	1144589	5632V	0	108423103	69570146596201035	-1433	79466
MSV073	381160	1144654	5539V	0	104422940	69479147758200907	-1020	80192
MSV074	381080	1144570	5711Y	0	105422795	69606147218200790	177	80803
MSV077	381490	1144467	5806Y	0	102423557	69737145184201391	-1563	78736
MSV078	381376	1144347	6005Y	0	116423350	69918143795201224	-911	78723
MSV079	381460	1144208	6107S	0	131423511	70117144240201347	372	79674
MSV081	382521	1144111	7834C	01120425477		70209135887202903	6725	81126
WRV088	381834	114591960400T		0	130424144	67606146182201895	1134	80663
WRV089	381658	1145884	5948C	0	102423820	67664146475201637	819	80634
WRV234	381409	1145929	5749V	0	102423358	67608147439201272	274	80767
WRV236	381315	1145870	5894V	0	113423186	67698146481201134	819	80829
WRV237	381243	1145740	6057B	0	151423057	67891145577201029	1555	81048
WRV238	381198	1145895	5761V	0	119422969	67666147154200963	412	80881
WRV240	381079	1145974	5543V	0	106422746	67556148209200789	-412	80788
WRV241	381020	1145814	5826S	0	134422642	67792146510200702	640	80903
WRV243	38 952	1145749	5815S	0	127422518	67889146204200603	330	80623

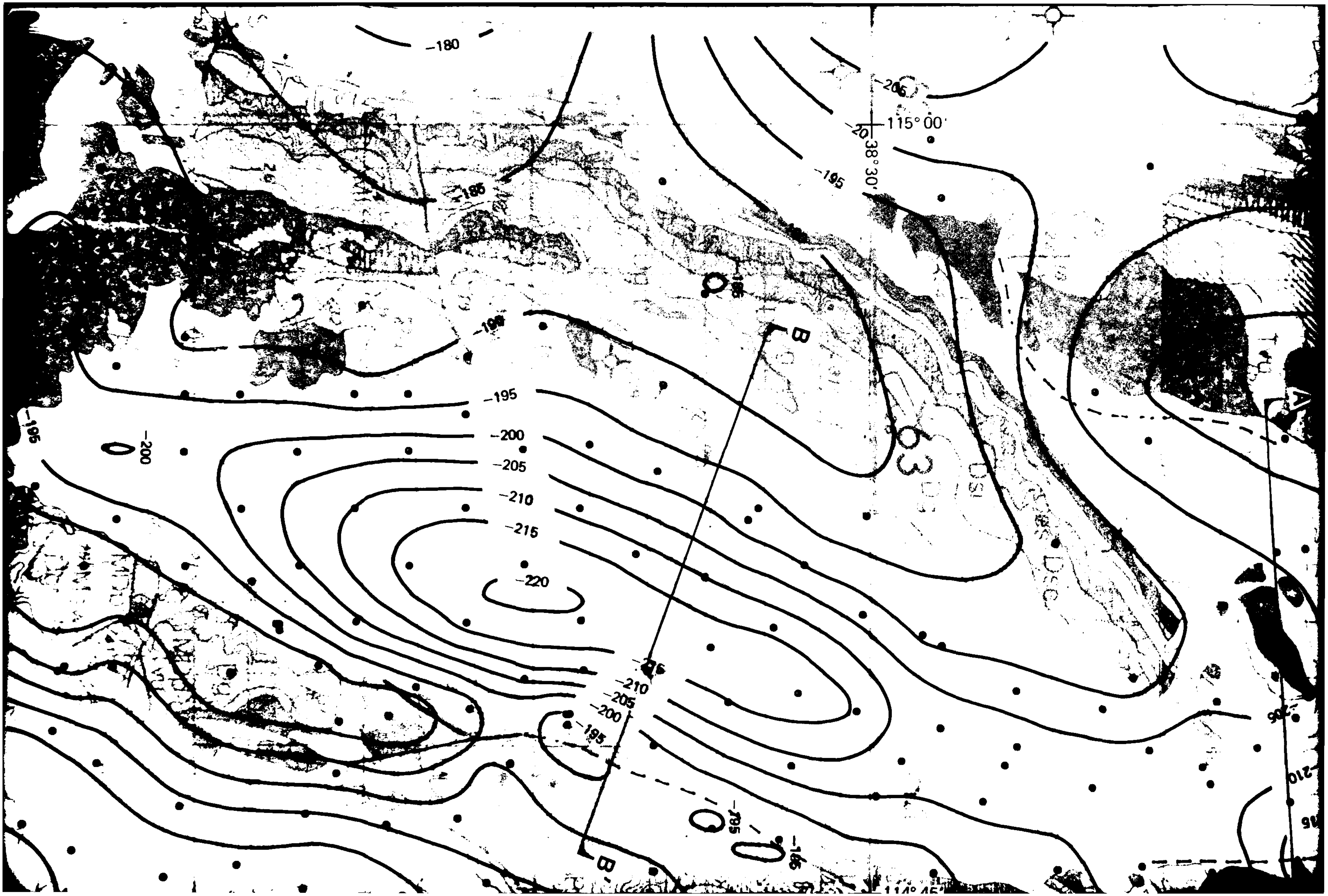
CAVE VALLEY GRAVITY DATA

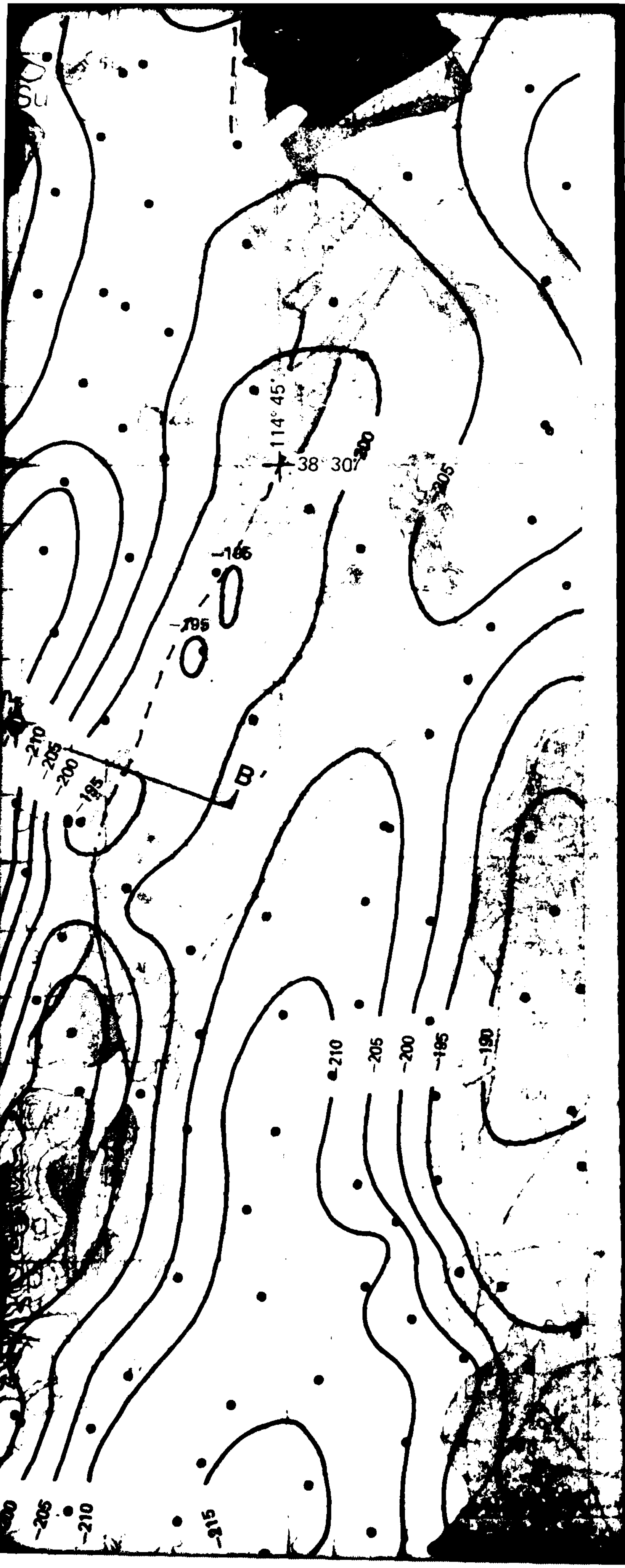
STATION	LAT.		LONG.		ELEV.		TER-COR.		NORTH	EAST	OBSV	THEO	FAA	CBA
IDENT.	DEG	MIN	DEG	MIN		+CODE	IN/	OUT	UTM	UTM	GRAV	GRAV		+1000
WRV244	38	952	114	5972	5459	S	0	101	422511	67564	147956	200603	-1270	80212
WRV245	38	852	114	5834	5535	S	0	105	422331	67769	147035	200456	-1329	79898
WRV246	38	730	114	5961	5240	V	0	100	422101	67589	147942	200278	-3020	79208
WRV247	38	704	114	5796	53770	T	0	96	422058	67831	147779	200240	-1856	79901
WRV249	38	591	114	5864	52549	T	0	98	421829	67736	148305	200060	-2298	79877



115°00'
38°45'
114°45'
38°45'
-215
-210
-215
A
A'

114° 45'
38° 45'
A
-210
-215


A
B
B'
115°00'
38°30'
-180
-195
-200
-205
-210
-215
-220



114° 45'
38° 30'
B
-185
-195
-200
-205
-210
-195
-200
-205
-210
-215
-190

EXPLANATION

FAULTS SHOWN ON GEOLOGIC BASE MAP

INFERRED FAULTS SHOWN ON GEOLOGIC BASE MAP

ALLUVIAL MATERIAL

ROCK (ALL PATTERNS)

GRAVITY STATIONS

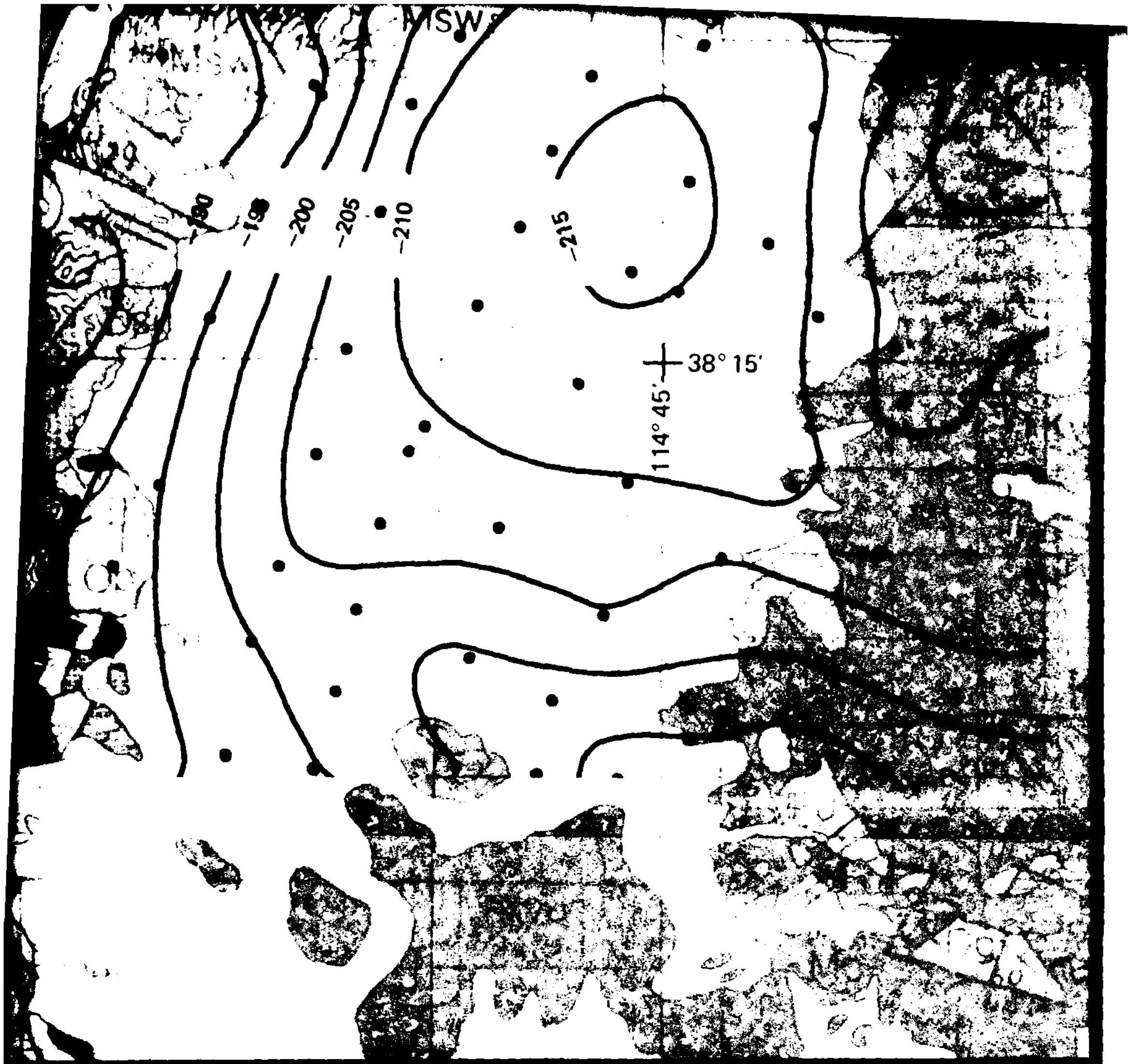
A A'

LOCATION OF PROFILE

CONTOUR INTERVAL = 5 MILLIGALS

GEOLOGIC BASE MAP: E.L. Howard (1978)

14 SEPT 81



ASE MAP

EOLOGIC BASE MAP

ALS

'd (1978)

NORTH

SCALE 1: 125,000

0 2 4

STATUTE MILES

0 2 4

KILOMETERS

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COMPLETE BOUGUER
ANOMALY CONTOURS
CAVE VALLEY, NEVADA

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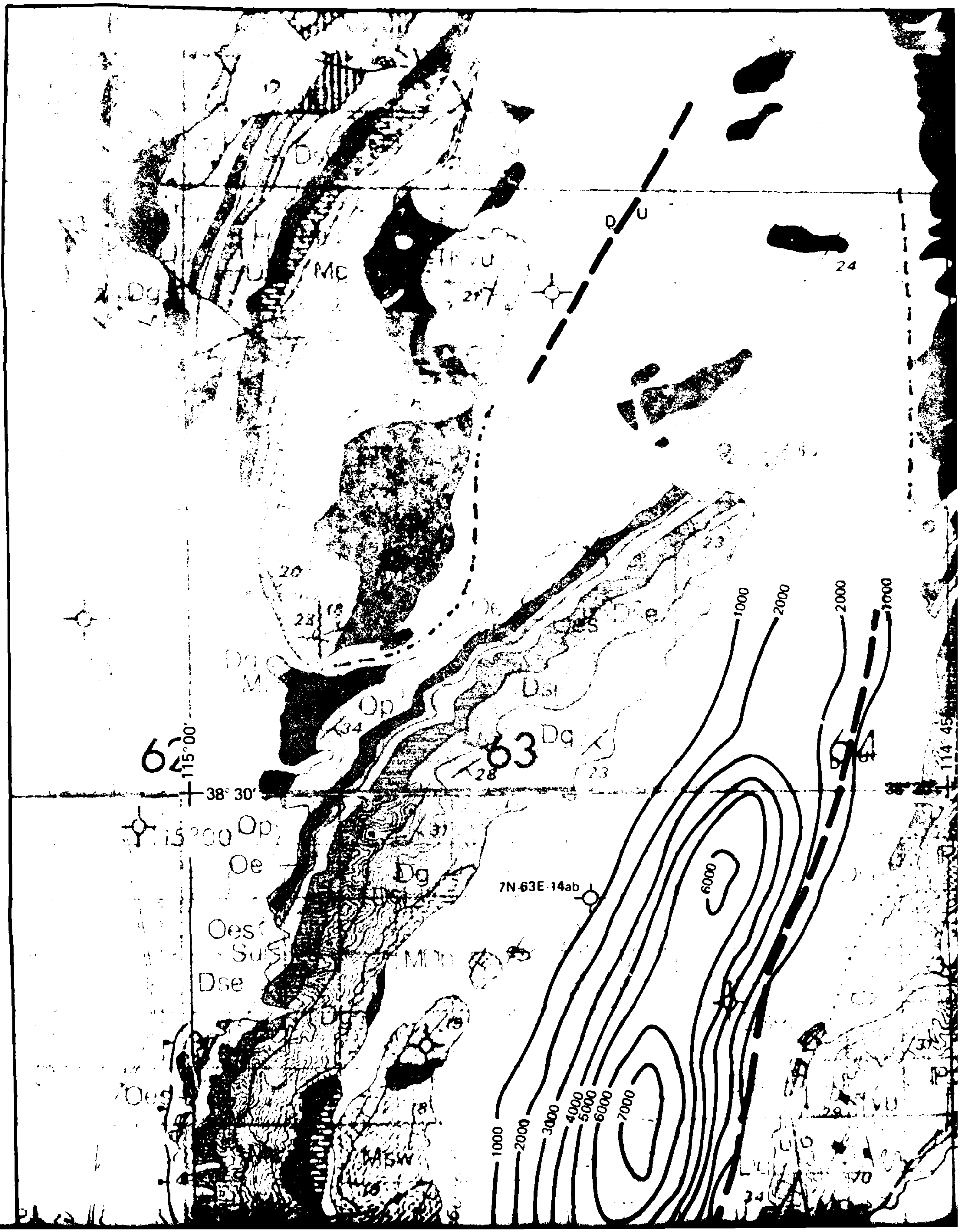
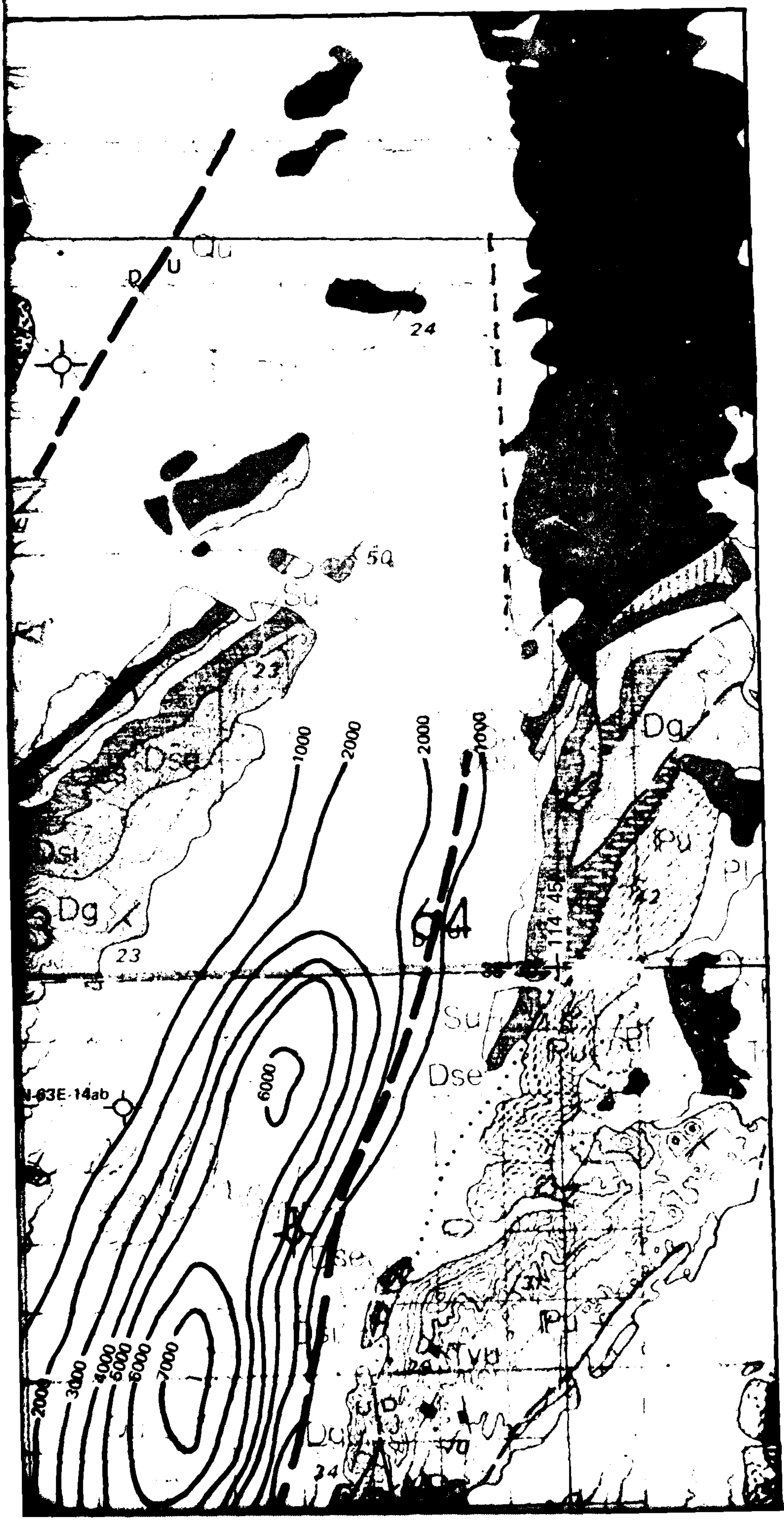
DRAWING 1


D
U
24
Mc
Dg
Op
34
62
63
Dg
28
23
38° 30'
115°00'
Op
Oe
Dg
Oes
Dse
Dg
20
28
1000
2000
6000
7N-63E-14ab
1000
2000
3000
4000
5000
6000
7000
MSw
114°45'

3



Qu
D
U
24
50
Su
23
Dse
Dsi
Dg
23
1000
2000
2000
1000
64
114°45'
Dg
Pu
Pl
42
Su
Pu
Dse
N-63E-14ab
6000
2000
3000
4000
6000
6000
7000
Pu
Tvb
Dg
70
34

EXPLANATION

FAULTS INFERRED FROM GRAVITY DATA

D

U

FAULTS SHOWN ON GEOLOGIC BASE MAP

ALLUVIAL MATERIAL

ROCK (ALL PATTERNS)

CONTOUR INTERVAL = 1000 FT.

DEPTH CALCULATIONS BASED ON
DENSITY CONTRAST OF -0.5g/cm^3

WELL

GEOLOGIC BASE MAP: E. L. Howard (1978)

SCA

0

0

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INTERPRET

CAVE

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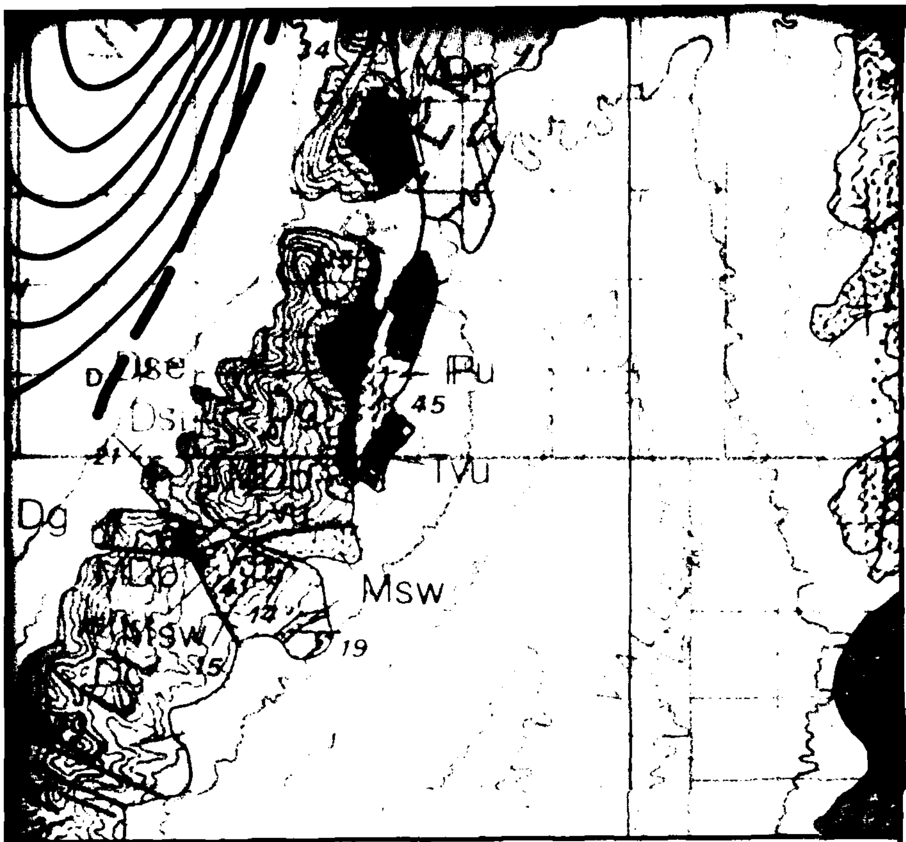

NORTH

SCALE 1: 125,000

0 2 4
STATUTE MILES

0 2 4
KILOMETERS

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DEPTH TO ROCK
INTERPRETED FROM GRAVITY DATA
CAVE VALLEY, NEVADA

14 SEPT 81

DRAWING 2